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Technology in critical institutionalism, the agency of the Seguia Khrichfa in reconfiguring irrigation institutions

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In this paper we want to highlight the important role technology plays in co-mediating institutions, opening up some courses of action and closing off others. We argue that the development of critical institutionalism requires recognition of the technological dimensions of institutions as the technology also shapes what institutions are, and what they can do. We show this by presenting a case study of a community managed irrigation system, the Seguia Khrichfa in Morocco. This is an ideal case to unravel the complexities in which technologies act. Human practises, and institutions, are interwoven with the canal they interact with, entwined in a shared history of co-defining each other. Through the water it carries, it links water users to each other (in a certain order, some more privileged than others). The canal does not restrict its network to a geographical area. At critical moments it links up to international discourses, agricultural policies and political relations.

In this paper, we approach institutions as the "codes of conduct" of human behaviour (Cleaver, 2012, p8). In irrigation societies, these are the pattern of rules, norms and roles that organize the allocation of water, the maintenance of the infrastructure and the resolution of conflict (Coward, 1980). Actors are involved in a continuous process to shape and re-shape institutions, a process to which Cleaver (2000) refers as "institutional bricolage". However, these codes of conduct in an irrigation system do not just come about through interactions between people, or between people and the environment, but also between people and technology (Latour, 1991). In this way, people, technologies and landscapes co-evolve to make certain ways of using and distributing water possible, while closing off others (Barnes, 2012). This process is not restricted to one specific community or locality, but plays out through and as a result of interactions (and sometimes struggles) with 'outsiders' – in terms of laws, funds and expertise. The technology negotiates and allies with other actors and is path dependent, shaped and constrained by the history that it has gone through and the liaisons that it makes with others. This continuous process of co-defining leads both to institutional bricolage *and* technical bricolage.

We present 5 instances of technological change in the historical trajectory of the Seguia Khrichfa that reconfigure institutions and mediate relationships between people and natural resources. For each instance, we describe the enacting conditions, a certain situation that (some) actors want to change. We then describe the technological solution that has been implemented. We end each instance by describing how this changed the

irrigation institution, which is the start for a new situation with its specific problems, to which new technological solutions are sought.

Instance 1: Lining main infrastructure

The Seguia Khrichfa is a secondary canal of the Bittit Irrigation System, which is fed by the Bittit sources at the Saiss Plateau, Morocco. During the French protectorate, the French governors registered water and land rights in order to turn the unclaimed land and water into state property. They registered the rights on the Bittit sources in a *Bulletin Officiel* in 1925. Sixty per cent of the source was assigned to the public sector, 16 % for the rural community Ait Ayach and 24 % for the rural community Ait Ouallal. The demand for water in Meknes grew, but the Ait Ouallals protested against the division of water rights between the Ait Ouallal, Ait Ayach and the public domain, that had been drawn up without their involvement. Consequently, to legitimately convey the 60% water of the public sector to Meknes for drinking water purposes, a state engineer calculated the efficiency of the earthen irrigation infrastructure of Ait Ouallal and Ait Ayach and concluded that lining the infrastructure with concrete would free up water for Meknes. The Department of Public works constructed a pipeline to Meknes (to convey 400 l/s) and lined the main canal of the Bittit irrigation system in 1950. Some privileged farmers, including a few colonial farmers, managed to get an individual intake in the main canal while the farmers along the secondary canals had to share water through rotational distribution system with a water turn: the first water user irrigates with all the discharge in the canal, then passes it to the next neighbour in line. The engineer of the Public Works Department designed the intakes (from the main canal into the secondary canals) on a specific discharge according to an updated *bulletin officiel* (90 l/s for the Seguia Khrichfa). This meant that there was no more possibility to adjust the discharge in each secondary canal to adapt to changing demands and cropping patterns. In order to still create flexibility, the *wakkaf* (ditch tender) adjusted the time of the water turn.

Instance 2: Rehabilitation of irrigation infrastructure. From the end of the 1970s onwards, in reaction to disappointing results in large scale irrigation systems, the international irrigation community started paying more attention to small scale, community managed irrigation systems, such as Bittit (Coward, 1980; Bouderbala et al., 1984). Meanwhile, a drought period put pressure on the Bittit sources, and competition between Meknes and the water users of Ait Ouallal grew. This is why the ministry of agriculture decided to start a rehabilitation project in 1981 for the Ain Bittit system. The project rehabilitated the irrigation system based on a common method in the large-scale irrigation systems: the secondary canals got lined and division boxes were inserted. As the lined canals would be more efficient then the earthen canals thus saving water, the project added extension of the command area to its objectives in and started de-stoning of previously unsuitable land.

Instance 3: Collective tube-well. After 1995, there were some more humid years, but the water users of the Seguia Khrichfa had created a higher demand for water due the new lands that were created with the de-stoning projects during two main rehabilitation projects and a shift in cropping systems (from cereals and tobacco to onions). During the drought period in the early 1980s, the state had drilled tube-wells in case of extreme droughts without equipping them with pumps. A second rehabilitation project, PMVB, equipped the well with an electric pump in 1997, thus adding the pumped water to the canal water. The equipment of the tube well created an on-demand distribution system on top of to the rotational distribution of the canal water.

Instance 4: Division boxes. The water users at the end of the canal, in Ait Brahim, could not benefit from the collective tube well most of the time, as the existing water turn would leave the tail-end dry when head-enders irrigated, and transporting only the discharge of the tube well to the tail-end was impossible due to high losses over the total length of the canal. While the rehabilitation project in 1981 had included the insertion of division boxes in the lined canals, water users did not use these boxes for a long time. Those division boxes have 5 gates of each the same size, allowing the *wakkaf* to divide the total discharge of the canal in 5 parts. Each $1/5^{th}$ of the discharge would then be distributed to a farmer in a subsector of the canal. In this way, there would always be a certain discharge over the whole length of the canal, never leaving a part of the canal dry. Instead of directly using this method after construction of the division boxes, the Khrichfa farmers preferred to get the total discharge when it was their turn, and at their own parcel, they would still split the total discharge in parts. In 2004, the water users organisation searched for a way to bind the Ait Brahim farmers to the Seguia Khrichfa as they started to drill private tube wells, thus threatening to opt out from the irrigation system. Four members of the water users organisation board convinced the water users to return to the original way of using the division boxes with the argumentation that it is a way to use water efficiently. However, instead of dividing the total discharge in 5 parts as was intended, they keep two gates permanently closed, dividing the water in three parts, as the farmers used to do on their individual fields.

Instance 5: Basins and drip irrigation. People from other regions, in search for work and attracted by the on-going rehabilitation projects in Bittit settled on the rain fed, collective lands above the Seguia Khrichfa and at the end of the canals reach. Nowadays, the new settlers search for ways to valorise this land. The division boxes have created a new possibility: to add new intakes to the canal. The settlers with rain-fed lands use this opportunity to create intakes at the right hand of the canal, allowing to fill basins on the rain fed land. From the basin onwards, they pump up the water to irrigate higher lying fields, which are more fertile and less parcelled then the lands within the irrigation system. The command area is thus moving uphill, towards the new settlers. The basins allow to stock water turns, which make the use of drip irrigation possible. The introduction of drip irrigation at some private parcels have inspired other water users as well. Currently, the water users organisation is starting a collective drip irrigation project. We foresee that also this change will re-shape the irrigation institutions. It changes the water allocation and its distribution, and it creates possibilities for certain water users and the plastic pipelines close off access to other uses.

Conclusion and discussion. In line with critical institutionalism thinking (cf. Cleaver, 2012), the Khrichfa case study shows that institutions are shaped by the negotiation between the actors involved. While the technology is an outcome of a negotiation process between actors, the technology itself also creates and shapes possibilities for certain actors and in certain directions (also described by Veldwisch et al., 2009, Barnes, 2012). Recognizing the agential force of the canal hinges on appreciating technology as something that is dynamic and change-able, as something that performs. Although some scholars define agency as the possibility to "make decisions and solve problems" (Merry, 2013, p 142) we see the agency of the technology as less straightforward; it is rather the capacity of the canal to co-shape codes of conduct.

The Seguia Khrichfa is created though a creative process of dealing with the arrangements and technologies at hand. Technological designs are borrowed from other systems or derived from prevailing paradigms. However, they are only used when the

irrigation community can make sense of them, when they fit with the constraints and the problems that the irrigation community faces. In some cases, they are used in a different way than they were supposed to, as the technology turned out to be useful to solve another problem. This is clearly illustrated by the division boxes: the insertion of the division boxes created a new possibility to adjust the water distribution to changing water demand and availability over the canal, but the water users' organization started using them only 20 years later, and in a different way as originally designed. This has created a hybrid community managed system, which maintains characteristics of a seguia irrigation system, but also displays modern features such as drip irrigation. Our analysis shows that the Seguia Khrichfa not only includes several modes of management, the canal also makes use of different and changing technologies, as such creating a hybrid irrigation system consisting of institutional *and* technical bricolage.

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